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54 Stable aerated frozen food product.

57 A process for preparing an aerated frozen food product such as mellorine or a shake beverage wherein water, fat, protein, emulsifier and stabilizer are blended together to form a mix which is homogenized to form an oil-in-water emulsion and is subsequently whipped under freezing conditions. Improved stability is achieved in the product by selecting a specific oil having high solid fat content at room temperature, homogenizing the mix of ingredients under conditions sufficient to form an emulsion having a relatively narrow distribution of small diameter fat globules, and aging the emulsion to crystallize the fat globules prior to whipping. Stable aerated frozen products provided in accordance with this invention can be stored and distributed at 0°F without loss of quality and have a variety of commercial uses.

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STABLE AERATED FROZEN FOOD PRODUCT

Frozen aerated food products to which this invention
15 is directed include frozen desserts such as ice cream, ice
milk, mellorine, sherbet, frozen custard, frozen pudding
and the like, frozen shake beverages such as milk shakes,
and frozen shake concentrate. The popularity of these
products is attributable to their convenience, widespread
20 availability, nutritive value and appealing forms, colors
and flavors. In part due to the familiarity of such
frozen products to the consumer, to be acceptable they
must not only have suitable flavor and appearance, but
also possess a complex set of physical properties which
25 provide the characteristics which consumers have come to
expect. In addition, the nature and composition of the
most popular aerated frozen products are set by various
standards promulgated by the U.S. Food and Drug Adminis-
tration as well as the individual states. Such rigid
30 consumer acceptance criteria, regulatory standards and the
complex nature of the interactions which produce a
satisfactory product make it extremely difficult to
reformulate such aerated frozen products in an attempt to
provide improvements. Solutions to one set of problems
35 quite often generate other problems which make the product
unacceptable.

Stability is one major problem of conventional aerated frozen products. For example, ice cream and related aerated frozen desserts are stored, distributed, delivered and sold at deep freeze temperatures, i.e. -20°F, to give some measure of stability to these products and protect against deterioration of their special textural properties. This storage and distribution system, however, has many drawbacks both from the consumer's and manufacturer's point of view. One problem is that, at deep freeze temperatures, the product is so hard that it is difficult to scoop and serve immediately from the deep freeze.

Another major problem is that temperature fluctuations invariably occur during storage and handling of aerated frozen products which result in the thawing and refreezing of the product, seriously deteriorating its quality over time. This "heat shock" is characterized by the formation of large ice crystals, and results in excessive hardening and gritty mouthfeel. Heat shock frequently also produces a separation of the syrupy aqueous phase from the air and fat matrix which ultimately make the appearance and texture of the product unacceptable.

25

Several solutions to these problems have been attempted in the past. For example, increased stability has been imparted to aerated frozen desserts through the use of various stabilizers and stabilizer combinations. The drawback of this approach is that stabilizers frequently are required in such great quantities that the feel of the product in the mouth is altered, producing a cloying, gummy or greasy sensation. Another approach has been to increase the amount of added sugars relative to the fat and/or water in the product, but the large amount of sugar required to provide acceptable stability often

results in too sweet a taste or unacceptable crystal formation. Still another approach has been to increase the amount of incorporated air, i.e., "overrun", and thereby decrease the amount of freezable water per unit
5 volume. This attempt at reformulation, however, not only results in a texture which is more characteristic of a whipped topping than of a frozen dessert like ice cream, but is limited by the applicable standards of identity relating to required weight per volume and solids content.

10

As a result of the instability of most aerated frozen desserts, producers have been required to manufacture the products locally to avoid the long periods of storage and temperature variations which are associated with national
15 distribution from a few centrally located plants. Since most producers, distributors and retailers rely on deep freeze temperatures for preserving the quality of ice cream-type desserts during storage, distribution and sale, totally separate systems are rerquired for such products
20 than are used for other frozen foods, which can be distributed at temperatures ranging from 0°F to 10°F. A very extensive network of frozen food storage, distribution and retailing facilities has been established nationwide, and therefore it can be seen that it would be
25 extremely advantageous from an economic and efficiency standpoint if an ice cream-type aerated frozen dessert of acceptable quality and stability could also utilize this system.

30 Milkshakes and similar frozen shake beverages are representative of another type of aerated frozen food product in which poor stability has limited the storage and distribution systems which the manufacturer can utilize. As is well-known, milkshakes are usually
35 manually prepared or dispensed from a commercial establishment for consumption on the premises. Various

attempts have been made in the past to provide products which are more widely available or are more susceptible to automated procedures. For example, milkshakes have simply been packaged in individual cups and frozen solid for
5 distribution. The product is then warmed under controlled conditions to room temperature, agitated or otherwise mixed, and served. Another approach has been to prepare and distribute a frozen milkshake concentrate which serves as a base to which milk or water is added with agitation.
10 Still another approach has been to aseptically can or bottle a prepared milkshake which is consumed after being chilled, shaken and opened. All of these prior approaches have either required unacceptably large amounts of time or space, required a reconstititional step which is either
15 difficult or time-consuming and/or have provided milkshakes which do not have the desired creaminess, coldness and consistency of commercially prepared milkshakes.

20 Since shakes are extremely popular items at fast food restaurants, it is of course important to reduce the time and labor involved in preparing large quantities of shakes manually. The present invention provides stable shakes which can be prepared in individual containers in central
25 locations and shipped in a frozen state to various restaurant locations where they are stored and served at refrigeration temperatures without any on-site preparation.

30 Accordingly, it is an object of this invention to provide aerated frozen food products which are stable for sufficient periods of time to allow national distribution under conditions and temperatures encountered in 0°F frozen food systems. Another object is to provide an
35 aerated frozen product which attains the aforesaid stability without a basic reformulation which would bring

the product outside the limits of consumer acceptance and regulatory standards. A still further object of the invention is to provide aerated frozen dessert products having the above attributes which are also soft and
5 scoopable at freezer temperatures. Another object is to provide shakes and similar beverages having the above attributes which retain the desirable characteristics of commercially prepared milkshakes when served at refrigeration temperatures (e.g. 15°F-25°F). A related object is
10 to provide a frozen shake concentrate which can readily be reconstituted by the consumer into a high-quality shake.

In accordance with one aspect of the invention, a process for preparing an aerated frozen food product,
15 wherein water, fat, protein, emulsifier and stabilizer are blended together to form a mix and said mix is homogenized to form an oil-in water emulsion which is subsequently whipped under freezing conditions, comprises:

20 selecting an edible oil which has an SFI of at least 25 to 70°F;

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the
25 average d_{vs} value is 0.2 to 1.5 microns, and a particle size distribution wherein the ratio of d_{vs} to d_{max} has a quotient in the range from 9 to 14;

30 aging the homogenized mix to crystallize said fat globules prior to said whipping and freezing; and

substantially retaining said particle size and
35 particle size distribution after said whipping and freezing.

In accordance with the present invention, therefore, the fat component of the aerated frozen food product comprises an edible oil which has a solid fat index (SFI) of at least 25 at 70°F. The mix containing this fat is
5 homogenized to form an emulsion of fat globules having an average volume/surface diameter (d_{vs}) of 0.2 to 1.5 microns, and a ratio of maximum fat globule diameter (d_{max}) to d_{vs} having a quotient of from 9 to 14. The emulsion is subsequently aged to crystallize the fat
10 globules prior to whipping. The vast majority of the fat in the product, i.e. at least 94%, is in the form of fat dispersed in the aqueous phase with only a small amount, i.e. less than 6%, in the form of free or de-emulsified fat. The overrun of the aerated frozen food product is
15 preferably from 50% to 110%.

The stable aerated frozen food products of the invention are extremely versatile and can be given a variety of textures and consistencies by varying the
20 formulation. A preferred embodiment of the invention comprises a stable mellorine product having 52% to 57% water in the form of ice crystals and an aqueous phase, ~~10% to 15%~~ of the aforementioned edible oil, 4% to 15% non-fat milk solids, and minor but effective amounts of
25 stabilizer and emulsifier. Preferably, the whipping step is sufficient to provide an overrun in the range of 60% to 90% in order to produce mellorine having the textural characteristics and appearance of conventional ice cream. Products having the characteristics of soft-serve ice
30 cream at 0°F may further comprise a freezing point depressant, preferably in the form of added sugars or other soluble solutes.

Ready-to-serve shake beverages having improved
35 stability are also provided in accordance with this invention by increasing the amount of water in the above-

mentioned formulation and lowering the overrun to achieve the desired shake consistency. Preferred shakes of the invention comprise about 63% to 68% water, 3% to 9% of the aforementioned edible oil, and about 50% to 70% overrun.

5 These shake products can be distributed through conventional frozen food systems in solid frozen form and then stored for several days at refrigeration temperatures (15°F to 25°F) before consumption without losing the desirable characteristics of commercially prepared
10 milkshakes. The invention can also be employed to provide a frozen concentrate to which water or other liquids are added at room temperature with stirring to produce shake beverages.

15 It has quite unexpectedly been found that the selection and processing of the fat component during the preparation of the aforementioned aerated frozen food products are critical elements in achieving the unique stability of this invention. Because of the solid fat
20 index (SFI) and other properties of the fat used, the small dispersed fat globules are substantially all crystallized during the aging step and a significant amount of these solid crystals are retained when the product is exposed to room temperature. Without intending
25 to be bound by theory, it is thought that the mobility of the aqueous phase during thawing and refreezing of the product is significantly restricted by these finely distributed fat crystals, thereby resulting in products which develop less iciness and retain overrun better when
30 exposed to heat shock than otherwise could be provided. This property in turn is thought to account in large part for the improved shelf life stability of the present products at typical frozen food temperatures.

Preparation in accordance with this invention results in aerated frozen food products which have sufficient stability to retain their desirable organoleptic properties for at least 50 days, and preferably as long as 180 days, at conditions which are normally encountered in typical 0°F frozen food storage, distribution and retailing systems. As a result, the products may be manufactured in a relatively few plants and distributed nationally and/or internationally using the same facilities as other frozen food items such as frozen vegetables, frozen entrees and frozen pizza. Frozen dessert products of the invention do not require a separate deep freezer in the retail store, and can be sold and/or consumed directly from the frozen food case or home freezer. The shake beverages of the invention can be delivered to the restaurant site frozen solid in individual containers and then stored and dispensed directly from a dispenser having a chamber in which the product has equilibrated to a temperature from 15°F to 25°F. Alternately, shakes can easily be prepared at home from a frozen concentrate of the invention stored in the home freezer. Preferably, 2 or 3 parts of frozen concentrate are diluted at room temperature (65°F to 75°F) with one part of water, or some other suitable liquid such as milk or juice, and then the diluted concentrate is stirred with a spoon to form the shake.

As briefly described above, the oils suitable for use in the practice of this invention have a Solid Fat Index (SFI) at 70°F of at least 25. SFI values are readily determined in accordance with standard analytical procedures using a dilatometer. Although the oil has a significant solid fat content at 70°F, it should be liquid at that temperature or easily liquefiable on warming and be substantially completely melted at about 100°F or slightly above. As used herein and in the claims the term

"oil" is intended to designate liquid fats meeting these requirements. Generally, the preferred oils are hydrogenated vegetable oils which have a (capillary) melting point between 70°F and 106°F, or blends of such vegetable oils. Suitable oils are derived from coconut, soybean, cottonseed, corn, palm kernel, peanut or the like. The solid fat in the most preferred oils melts quickly between 70°F and 100°F and these oils exhibit a sharp peak on a Differential Scanning Calorimetry curve. Since ice cream, ice milk, and milkshake standards require the use of butter fat, it is contemplated that high melting point fractions of butter oil meeting the SFI requirements of the invention could also be used to produce stable ice cream, ice milk, and milkshake products in accordance with this invention.

The amount of the fat component will vary depending on the aerated frozen food product being prepared and the particular organoleptic properties desired. Generally, the amount of the fat component comprises about 3% to 30% by weight of the frozen product, with the preferred mellorine products comprising 5% to 30% fat, most preferably 10% to 15% fat. The most preferred shake products of the invention comprise from 3% to 9% fat.

The fat component of this invention can be mixed with other ingredients at ambient temperatures but is preferably injected at an elevated temperature, e.g. about 160°F, into the aqueous mix containing the other ingredients. The resultant mixture is then homogenized, primarily to reduce the size of the fat globules and form a stable oil-in-water emulsion. In accordance with the preferred embodiment of the invention, the mix is homogenized at a low pressure, i.e., a total pressure below 6000 psig, to provide a uniform distribution of small fat globules in the emulsion.

The designations " d_{vs} " and " d_{max} " used herein and in the appended claims to characterize the particle size of the emulsion are derived from the spectroturbidimetry method described in detail by Walstra [P. Walstra, 5 Estimating Globule-Size Distribution of Oil-in-Water Emulsions by Spectroturbidimetry. J. Coll. Interf. Sci. Vol. 27, No. 3, P. 493-500 (1968); and P. Walstra, Light Scattering by Milk Fat Globules, neth. Milk and Dairy J., Vol. 19, No. 2, P. 93-109 (1965)]. In general, this 10 technique is based on the principle that the turbidity of an emulsion such as milk can be used to determine the average particle size and particle size distribution of the dispersed oil phase. In this method, a light beam is directed through the emulsion and the light scattering 15 coefficient is taken as a function of a dimensionless number derived from the particle size of the suspended fat globules and the wavelength of the light. The transmittance and absorbance of the light beam incident on the emulsion contained in a standard cell is measured for 20 various wavelengths using a spectrophotometer, and then these values are used to construct a light scattering spectrum. Homogenized emulsions typically show a log normal frequency-volume distribution, so a computer is used to generate a theoretical light scattering spectrum 25 based on a log normal particle size distribution. The volume/surface average diameter of the fat globules (herein and in the claims referred to by the designation d_{vs}) and the maximum emulsion diameter (herein and in the claims referred to by the designation d_{max}) are mathe- 30 matically calculated from the "fit" of the experimentally derived curve to the theoretical curve.

In accordance with the present invention, the mix is homogenized to provide a d_{vs} of 0.2 to 1.5 microns, 35 preferably 0.2 to 0.5 microns, with the ratio of d_{max}/d_{vs} having a quotient of from 9 to 14. As previously stated,

this relatively narrow distribution of small fat globules in combination with the solid fat characteristics of the oil used has been found to be very important in achieving the improved shelf-life characteristics of the present invention.

Homogenizers commonly used in ice cream manufacture may be employed to homogenize the mix. Although homogenizing techniques not utilizing pressure may be used, a homogenization pressure not in excess of a total of 6000 psig is preferred. In fact, one advantage of the present invention is that the desired homogenization can be achieved at pressures lower than that usually employed in conventional ice cream manufacture, e.g. pressures below 3000 psig. Homogenization is preferably accomplished at temperatures of 110°F to 180°F.

The vigorous agitation of the mix during freezing and whipping inevitably results in some destabilization of the fat emulsion in the form of fat "churnout" or "de-emulsification", i.e., a coalescence wherein the fat globule loses its identity as a dispersed entity and forms pools, and/or "clumps" together to form larger particles. In addition, the emulsion prior to whipping may inherently contain some of this "free" fat. The current understanding in the ice cream art is that such physical properties as dryness and stiffness are related to the degree of de-emulsification of the fat. It is believed that too little de-emulsification results in a wetter-appearing and less stiff ice cream, whereas too much de-emulsification may result in a courser texture. In addition, a coating of de-emulsified fat around the air cells tends to improve the foam stability of the product and is considered desirable. However, too much de-emulsified fat in the continuous phase may give a fatty or too creamy sensation to the frozen product.

It has quite surprisingly been found that the products of this invention exhibit considerably less fat de-emulsification, or free fat, than conventional frozen desserts and shake products. In the present products, at least 94% of the total fat is in the emulsified form and less than 6% of the total fat is in the de-emulsified form, whereas conventional ice cream, for example, typically has about 13% of the total fat in the de-emulsified form. The relatively narrow distribution of small fat crystals produced as a result of the homogenization and aging steps of the invention is substantially retained after the freezing and aeration step and this in turn is believed to contribute to this low incidence of de-emulsified fat.

15

De-emulsified fat can be extracted by hydrophobic organic solvents such as chloroform because of its "free" character, whereas emulsified fat cannot. Therefore, the level of de-emulsified fat in the frozen product can readily be determined by mixing a sample with chloroform, removing the chloroform soluble fraction, evaporating the chloroform and weighing the residue. De-emulsified fat so determined is then expressed as a percentage of the total fat.

25

The fat component of the invention may be used with mono and diglyceride emulsifiers and other emulsifiers normally used in aerated frozen food products and/or permitted by the applicable standards of identity. Such emulsifiers are typically used in amounts ranging from 0.1% to 0.5%, preferably less than 0.3%. The emulsifiers may be conveniently melted with the fat component and metered together into the mix prior to homogenization.

30

The mix may be pasteurized before or after homogenization in accordance with known commercial procedures. For example, continuous high temperature/short time (HTST) pasteurization is the most common method used by the
5, larger ice cream plants and is suitable for the practice of the present invention. Minimum pasteurization standards for ice cream mix recommended by the U.S. Public Health Service are 175°F for 25 seconds for the HTST method, and 155°F for 30 minutes for the alternative
10 holding method.

Following homogenization and pasteurization, the mix is rapidly cooled and held ("aged") at 30°F to 45°F for a time sufficient to cause extensive crystallization of the
15 fat globules, usually from 2 to 12 hours. It is believed that the resultant distribution of small fat crystals which retain a significant amount of solid fat at room temperature not only aids in the freeze-thaw stability of the product by providing physical barriers limiting the
20 mobility of the aqueous phase, but also contributes to improved physical properties of the frozen product, such as a smoother texture.

After sufficient aging, the mix is simultaneously
25 aerated ("whipped") and frozen in the conventional manner. In a continuous freezer, the mix is rapidly cooled to freezing temperature and air is simultaneously incorporated to form the basic foam structure of small uniformly dispersed air cells. These processes take place
30 under conditions of vigorous agitation provided by a "mutator", a rotating cylindrical device equipped with scraper blades and a whipping mechanism. The residence time during freezing is usually on the order of 25 to 30 seconds. As freezing proceeds, the mass becomes
35 increasingly viscous and is finally extruded into containers from the freezer in a stiff plastic condition.

The product may then be further frozen (hardened) at a temperature of about -40°F to -80°F prior to storage at typical frozen conditions.

5 The amount of incorporated air, i.e., the "overrun", is important to the overall stability of aerated frozen products, yet must be controlled within certain limits to provide an acceptable texture and appearance. Generally, the higher the overrun, the lower the amount of water per
10 unit of volume, and therefore the more resistant the product is to the formation of the large ice crystals after heat shock. Although high overrun aerated frozen products exhibit increased stability, increasing the overrun to improve the stability will not always produce
15 an acceptable product since there are limits placed on the amount of air incorporated in the product, both by the various standards of identity and consumer preference. For example, federal regulations on solids content and weight/volume relationships for ice cream and related
20 products, such as mellorine and ice milk, effectively limit the overrun to about 110%. Frozen desserts having overruns in excess of this amount tend to exhibit textural properties which are not characteristic of ice cream, and therefore are not preferred by consumers. The practice of
25 the present invention is particularly advantageous for stabilizing ice cream-type frozen desserts without requiring overruns over 110%. Although products of this invention generally comprise less water than conventional ice cream-type products, they have similar overrun so as
30 to retain the familiar textural properties of ice cream. Preferably, the frozen mellorine desserts and shake concentrates described herein comprise from 45% to 68% water, with 52% to 57% water being the most preferred range. Overrun for these products is usually from 50% to
35 110%, preferably about 60% to 90%.

There are no existing standards which dictate the amount of overrun in milkshakes and similar frozen shake products. However, such products usually become too foamy to be acceptable at overruns of 80% or over, and too
5 liquid or thin at overruns of 30% or below. For the ready-to-serve frozen shakes of this invention, the preferred water content is 63% to 68% and the preferred overrun is about 50% to 70%.

10 A stable foam (aerated) phase imparts a structural rigidity to the subject frozen food products and aids in limiting the mobility of the aqueous phase which causes the separation of the phases during prolonged storage. To
15 this end, foam stabilizers are useful in the practice of the present invention. Among the most useful stabilizers are the hydrophilic colloids, or hydrocolloids, commonly referred to as "gums". These long-chain high-molecular-weight polymers disperse in the aqueous phase and/or
20 interact with other product ingredients to provide a thickening or gelling effect which stabilizes the foam structure. They also contribute to the stability of the product by serving as water-binding ingredients which limit the mobility of the aqueous phase. Common gums
25 suitable for use in the present invention include natural gums such as carrageenan, guar gum, locust bean gum, xanthan gum, gelatin, alginates, pectin, dextran, glucan and the like, as well as modified natural gums such as carboxymethyl cellulose, methylcellulose ether and other modified cellulose derivatives, modified starch,
30 polyacrylic acid, and the like, and various mixtures thereof. The permitted quantities of gums may be governed by federal and/or state regulations, as well as by consumer preference regarding such physical properties as mouth feel and melt-down rate. The unique stability
35 characteristics of the products of this invention allow

very small amounts of stabilizers to be used, preferably quantities much less than 1% and most preferably less than 0.3%.

5 Aerated frozen dessert products of the invention may be given hardness and texture at 0°F which simulate that of commercially available soft-serve ice cream. Conventional soft-serve ice cream products are usually prepared using machinery located on the premises where they are
10 consumed and are served at temperatures slightly below freezing, e.g., 15°-25°F. Accordingly, these products characteristically have poor keeping qualities which prevent their effective distribution and storage off premises. If exposed to the deep freeze temperatures
15 necessary to prolong their shelf life, conventional soft-serve products become very hard and cannot be scooped from a container for serving. To solve this problem, aerated frozen dessert products sometimes include greater than normal quantities of sugars, alcohols and other low
20 molecular weight compounds to lower the freezing point of the aqueous phase to an extent where the product is soft and scoopable and has a soft-serve texture at freezer temperatures. Frozen shake concentrates are also made more easily dispersible by the addition of such compounds.
25 It has been found that the use of such freezing point depressants is compatible with the practice of the present invention and that the unique stability of the products can readily be achieved with formulations including such compounds.

30

The most useful freezing point depressants in the practice of this invention are sugars which not only have a sweetening effect, but also enhance the creamy texture of the product. The choice of sugars employed is
35 controlled by the degree of freezing point depression desired and also by flavor and texture effects resulting

from the addition of such sugars. An insufficient amount of sugar will produce an off-taste in the product, whereas too much sugar will produce excessive sweetness and may mask other desirable flavors. Different sugars also lower
5 the freezing point of the product to varying degrees, depending on their molecular weights.

Preferably, the amount of added sugars in the products of this invention is 18% to 33% by weight. It
10 has been found that the most desirable balance of sweetness and textural properties may be achieved by employing sucrose in combination with one or more sugars which are less sweet; for example, sucrose may be combined with dextrose, lactose, low-conversion corn syrup, etc; in
15 order to obtain the benefits of a relatively large proportion of sugar at a level of sweetness which is less than that resulting from the use of an equal amount of sucrose alone.

20 The products of this invention comprise 4% to 15% non-fat milk solids. Although non-fat milk solids are the preferred source of protein, it is contemplated that other suitable frozen dessert proteins, such as casein, caseinates, whey protein concentrate, egg protein, and
25 soy, peanut and/or vegetable proteins may be used. Non-fat milk solids are the solids of skim milk and can be added in dry form or as condensed skim milk. These solids include proteins, minerals and milk sugar. Milk sugar adds to the sweet taste of the frozen product and proteins
30 aid in the development of the desired overrun as well as contribute to the desirable texture and body of the product. The use of larger amounts of non-fat milk solids increases the effect that whipping has on the frozen product and increases the viscosity and resistance to
35 melting of the composition. They also tend to lower the freezing point of the product. Non-fat milk solids which

contain not less than 2.5 mg/g undenatured whey protein nitrogen per gram of milk solids, as determined by the procedure set forth in American Dry Milk Institute Bulletin 916, are preferred.

5

The following examples are intended to illustrate the present invention, and are not to be construed as limiting the invention in any way:

10

Example I

A series of six frozen aerated desserts were prepared containing the following ingredients in parts by weight:

15

Parts/Weight

	Non-fat Dry Milk Solids	6.60
	Fat Component	12.00
	Dextrose	21.2
20	Sucrose	4.10
	Corn Syrup	2.40
	Xanthan Gum	0.264
	Carrageenan	0.004
	Emulsifier	0.10
25	Flavoring	0.40
	Coloring	0.84
	Water	52.10

The samples were made according to the following
30 procedure:

48 pounds of the fat component was melted with 0.4 pounds of the emulsifier component by heating to a temperature of 110°F in a 70 gal. jacketed container to
35 form the fat phase. 26.4 pounds of non-fat dry milk solids was dispersed in 206 pounds of water and the

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remaining ingredients (122 pounds) were added to form the aqueous phase. The fat and aqueous phases were mixed together at 160°F, homogenized at a pressure of 1500 psi, and the emulsion thus formed was pasteurized at 175°F for 25 seconds. The mix was then cooled to between 30°F and 40°F and aged for 12 hours at 40°F. The aged mix was aerated in an ice cream freezer at about 16°F to provide an overrun of about 75%, extruded into suitable containers, hardened at a temperature of -40°F to -80°F and stored in a 0°F freezer.

The SFI values of the fat components employed in the six samples were as follows:

15	Sample	<u>SFI at 100°F</u>	<u>Fat Component</u>	<u>SFI at 70°F</u>
	A		Coconut Oil	46.10
	B		Coconut Oil	37.40
20	C		Coconut Oil	26.60
	D		Soy/Coconut Oil Blend	20.00
	E		Soybean Oil	16.90
	F		Anhydrous Butter	13.80

25 The average fat particle size (d_{vs}) of each sample was from 0.2 to 0.5 microns, and the d_{max}/d_{vs} quotient was in the range from 9 to 14. The amount of free fat for each sample was 2% to 3% using the chloroform extraction method.

30

The samples were subjected to conditions which were representative of those encountered in a typical 0°F distribution system. Samples in their containers on a "mock" pallet were removed from the 0°F freezer, kept for

2-4 hours at room temperature (about 70°F), and then placed back in the 0°F freezer for 20-22 hours. This procedure was repeated 4 or 5 times.

5 After undergoing the above freeze-thaw cycles, the samples were submitted to test panels consisting of 10 to 15 people, who were asked to rate them for iciness and softness. Samples A, B, and C incorporating the present invention were judged by the panels to be acceptable,
10 whereas the remaining samples not incorporating the invention were determined to be unacceptable.

Example II

15 A Sample G employing the coconut oil of Sample B was prepared and subjected to heat shock in accordance with the procedure described in Example I, except that Sample G was prepared in a low shear device (i.e. an Oakes mixer) to provide an average particle size (d_{vs}) of 6.4 microns
20 and a ratio of d_{max} to d_{vs} having a quotient of 2.0. Sample G was considered to be unacceptably unstable to heat shock and was judged to be icy and coarse by the evaluation panel.

Example III

25 A frozen shake product was prepared using the procedure of Example I and the following formula:

Parts/Weight

	Non-fat Dry Milk Solids	10.000
	Coconut Oil	5.715
5	Dextrose	14.000
	Sucrose	6.000
	Xanthan Gum	0.175
	Carrageenan	0.060
	Emulsifier	0.100
10	Flavoring	0.400
	Coloring	0.400
	Water	63.150
	Overrun	60%

15 This product (Sample H) was extruded into a 14 fl. oz. waxed paper cup and placed in a 20°F refrigerator along with a prior art frozen shake (Sample I) made in accordance with Arbuckle U.S. Pat. No. 3,479,187. Samples H and I were taken from the refrigerator, and along with

20 Sample J, a typical fast food restaurant shake, they were allowed to sit at room temperature (72.4°F) for 40 minutes. Both Sample I and J exhibited symptoms of instability after this time. Sample J developed a phase separation band about 2 cm wide at the bottom, and large

25 (about 0.3 cm diameter) air bubbles on the top to give a very foamy appearance. Sample I developed a rim of fluid around an unappealing icy lump in the center of the shake. However, there were no significant changes observed in Sample H, during this time period, thereby demonstrating

30 the superior stability of the shake beverages of the present invention when compared to prior art products.

CLAIMS:

1. A process for preparing an aerated frozen food product, wherein water, fat, protein, emulsifier and
5 stabilizer are blended together to form a mix and said mix is homogenized to form an oil-in-water emulsion which is subsequently whipped under freezing conditions, characterized in that it comprises:

10 selecting an edible oil which has an SFI of at least 25 at 70°F;

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the
15 average d_{vs} value is 0.2 to 1.5 microns, and a particle size distribution wherein the ratio of d_{vs} to d_{max} has a quotient in the range from 9 to 14;

20 aging the homogenized mix to crystallize the fat globules prior to the whipping and freezing; and

25 substantially retaining the particle size and particle size distribution after the whipping and freezing.

2. A process as defined in claim 1, characterized in
30 that the mix is homogenized at a pressure less than 6000 psig.

3. A process as defined in claim 1 or claim 2 characterized in that the homogenized mix is aged at 30°F to
35 45°F for 2 to 12 hours prior to whipping and freezing.

4. A process as defined in any one of claims 1 to 3, characterized in that the aged mix is whipped to an overrun of 50% to 110% to provide a frozen dessert product.

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5. A process as defined in any one of claims 1 to 3, characterized in that the aged mix is whipped to an overrun of about 50% to 70% to provide a frozen shake product.

10

6. A process for preparing a stable aerated frozen dessert product, characterized in that the process comprises the steps of:

15

mixing 45% to 68% water, 3% to 30% edible oil having an SFI of at least 25 to 70°F, 4% to 15% non-fat milk solids, and minor but effective amounts of stabilizer and emulsifier to form a mix;

20

homogenizing said mix to form an emulsion of fat globules having a particle size wherein the average d_{vs} value is 0.2 to 1.5 microns and a particle size distribution wherein the ratio of d_{vs} value is 0.2 to 1.5 microns and a particle size distribution wherein the ratio of d_{vs} to d_{max} has a quotient of from 9 to 14;

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aging the homogenized mix at 30°F to 45°F for 2 to 12 hours to crystallize said fat globules;

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whipping the aged mix under freezing conditions
to an overrun of 50% to 110%; and

5 substantially retaining said particle size and
particle size distribution after said
whipping and freezing.

7. A process as defined in claim 6, characterized in
10 that the oil and emulsifier are melted together and
injected just prior to homogenization into a solution of
the remaining ingredients in the water.

15 8. A process as defined in claim 6, characterized in
that the aerated frozen dessert is hardened at -40°F to
-80°F after whipping.

20 9. A process as defined in claim 8, characterized in
that the hardened aerated frozen dessert is stored,
distributed, sold and consumed at 0°F to 10°F.

25 10. A process as defined in claim 8, characterized in
that 2 to 3 parts of the aerated frozen dessert are
diluted at room temperature with one part of liquid and
stirred to form a shake beverage.

30

11. A process for preparing a stable shake beverage,
characterized in that the process comprises:

5 mixing 63% to 68% water, 3% to 9% edible oil
having an SFI of at least 25 to 70°F, 4% to
15% non-fat milk solids, and minor but
effective amounts of stabilizer and
emulsifier to form a mix;

10 homogenizing said mix to form an emulsion of fat
globules having a particle size wherein the
average d_{vs} value is 0.2 to 1.5 microns and
a particle size distribution wherein the
ratio of d_{max} to d_{vs} has a quotient of from
9 to 14;

15 aging the homogenized mix at 30°F to 45°F for 2
to 12 hours to crystallize said fat
globules;

20 whipping the aged mix under freezing conditions
to an overrun of 50% to 70%;

substantially retaining said particle size and
particle size distribution after said
whipping and freezing;

25 placing the aerated frozen product into
individual containers; and

30 allowing said aerated frozen product to
equilibrate to a temperature of from 15°F
to 25°F until it develops a shake
consistency.

12. A process as defined in claim 11, characterized in
35 that the aerated frozen product is hardened at -40°F to
-80°F after it is placed into individual containers.

13. A stable aerated frozen food product characterized in that it is formed by a process which comprises the steps of:

5 mixing 45% to 68% water, 3% to 30% edible oil
 having an SFI of at least 25 to 70°F, 4% to
 15% non-fat milk solids, and minor but
 effective amounts of stabilizer and
 emulsifier to form a mix;

10 homogenizing said mix to form an emulsion of fat
 globules having a particle size wherein the
 average d_{vs} value is 0.2 to 1.5 microns and
 a particle size distribution wherein the
15 ratio d_{vs} to d_{max} has a quotient of from 9
 to 14;

 aging the homogenized mix at 30°F to 45°F for 2
 to 12 hours to crystallize said fat
20 globules;

 whipping the aged mix under freezing conditions
 to an overrun of 50% to 110%; and

25 substantially retaining said particle size and
 particle size distribution after said
 whipping and freezing.

30 14. A stable ready to serve shake beverage, characterized
 in that it is formed by a process which comprises:

- 5 mixing 63% to 68% water, 3% to 9% edible oil
having an SFI of at least 25 to 70°F, 4% to
15% non-fat milk solids, and minor but
effective amounts of stabilizer and
emulsifier to form a mix;
- 10 homogenizing said mix to form an emulsion of fat
globules having a particle size wherein the
average d_{vs} value is 0.2 to 1.5 microns and
a particle size distribution wherein the
ratio of d_{max} to d_{vs} has a quotient of from
9 to 14;
- 15 aging the homogenized mix at 30°F to 45°F for 2
to 12 hours to crystallize said fat
globules;
- 20 whipping the aged mix under freezing conditions
to an overrun of 50% to 70%;
- substantially retaining said particle size and
particle size distribution after said
whipping and freezing;
- 25 placing the aerated frozen product into
individual containers; and
- 30 allowing said aerated frozen product to
equilibrate to a temperature of from 15°F
to 25°F until it develops a shake
consistency.
15. A product as defined in claim 14, characterized in
35 that it has an overrun of 50% to 110%.

16. A product as defined in claim 14 or claim 15,
characterized in that at least 94% of said oil is
dispersed in said aqueous phase in the form of said
crystallized fat particles and less than 6% of said oil is
5 in the form of de-emulsified fat.

17. A food product whenever formed by the process as
claimed in any one of claims 1 to 12.
10

18. A stable aerated frozen food product, characterized
in that it comprises:

15 45% to 68% water in the form of ice crystals and
an aqueous phase;

4% to 15% non-fat milk solids;

20 3% to 30% edible oil having an SFI of at least
25 at 70°F, a majority of said oil being
dispersed in said aqueous phase in the form
of crystallized fat particles having a d_{vs}
value of 0.2 to 1.5 microns and a ratio of
25 d_{max} to d_{vs} having a quotient of from 9 to
14; and

minor, but effective, amounts of emulsifer and
stabilizer.

30

19. A product as defined in claim 18, characterized in
that it has an overrun of 50% to 110%.

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20. A product as defined in claim 18, characterized in that at least 94% of said oil is dispersed in said aqueous phase in the form of said crystallized fat particles and less than 6% of said oil is in the form of de-emulsified fat.

21. A product as defined in claim 18, characterized in that it further comprises a hydrocolloid stabilizer system in a quantity less than 1%.

22. A product as defined in claim 18, characterized in that it comprises 0.1% to 0.5% emulsifier.

23. A stable frozen mellorine product, characterized in that it comprises:

52% to 57% water in the form of ice crystals and an aqueous phase;

4% to 15% non-fat milk solids;

10% to 15% edible oil having an SFI of at least 25 at 70°F, at least 94% of said oil being dispersed in said aqueous phase in the form of crystallized fat particles having a d_{vs} value of 0.2 to 0.5 microns and a ratio of d_{max} to d_{vs} having a quotient of from 9 to 14, and less than 6% of said oil in the form of de-emulsified fat;

18% to 33% added sugars; and

an overrun of 60% to 90%.

5

24. A stable ready-to-serve shake beverage characterized in that it comprises:

10 63% to 68% water in the form of ice crystals and an aqueous phase:

4% to 15% non-fat milk solids;

15 3% to 9% edible oil having an SFI of at least 25 at 70°F, at least 94% of said oil being dispersed in said aqueous phase in the form of crystallized fat particles having ad_{vs} value of 0.2 to 1.5 microns and a ratio of d_{max} to d_{vs} having a quotient of from 9 to 20 14, and less than 6% of said oil in the form of de-emulsified fat;

18% to 33% added sugars;

25 0.1% to 0.3% mono- and/or di-glyceride emulsifiers;

less than 0.3% of a hydrocolloid stabilizer; and

an overrun of 50% to 70%.



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Y	US-A-3 914 440 (RALPH P. WITZIG) * Column 2, lines 5-14; column 3, line 61 - column 4, line 3 *	1,2,6,9,17	A 23 G 9/02 A 23 G 9/04
Y	US-A-4 421 778 (MARVIN L. KAHN et al.) * Column 3, lines 25-27; column 6, lines 25-30; claims 1,25 *	1,2-6,9,10,17	
Y	GB-A-2 045 050 (D. TRESSER) * Page 3, lines 50-60; page 2, lines 20-27 *	1,2,4,6,17	
Y	US-A-4 368 211 (J.R. BLAKE et al.) * Column 7, lines 20-25; examples 1-3; column 8, lines 30-41 *	1-10,17	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
Y	MILK PLANT MONTHLY, June 1948, pages 42-50; L.L. LITTLE: "Emulsifying and stabilizing agents for ice cream" * Page 44, column 2, paragraph 2; page 50, column 2, paragraph 4 *	1	A 23 G
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27-07-1984	Examiner GUYON R.H.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Y	US-A-4 031 261 (J.R. DURST) * Examples 1-13; column 3, lines 14-24; claim 15; column 12, lines 30-35; column 6, lines 50-68 *	1, 9, 10, 17	
A	--- US-A-3 431 117 (G.J. LORANT) * Column 2, lines 34-37; column 3, lines 45-50; column 3, lines 15-17; claims 1-8 *	1	
A	--- US-A-3 889 001 (N.F. BUIDE et al.)		
A	--- FR-A- 868 427 (SOC. ASTRA) * Abstract no. 1a *	7	
A	--- US-A-4 346 120 (R.G. MORLEY et al.)		
A	--- US-A-3 949 102 (J.A. HELLYER et al.)		
E, X	--- US-A-4 434 186 (NITIN-DESIA et al.)	1-24	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	--- US-A-3 993 793 (D.J. FINNEY) -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27-07-1984	Examiner GUYON R.H.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p>			